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In re Japanese Application of

Yasuaki TSUCHIYA et al.

Japanese Patent Application No.: 2002-225734

Filing Date: August 2, 2002

for: "Slurry for Polishing Copper-based Metal"

VERIFICATION OF TRANSLATION

Honorable Commissioner of Patents and Trademarks

Washington, D.C. 20231

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June 29, 2005

Date

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(translation)

JAPAN PATENT OFFICE

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[Title of the Invention] Slurry for Polishing Copper-based Metal

[Claims]

[Claim 1] A slurry for polishing copper-based metal containing a silica 5 polishing material, an oxidizing agent, an amino acid, a triazole-based compound and water, wherein a content ratio of said amino acid to said triazole-based compound (amino acid / triazole-based compound (weight ratio)) is 5 to 8.

[Claim 2] The slurry for polishing copper-based metal according to 10 Claim 1, wherein said amino acid is glycine.

[Claim 3] The slurry for polishing copper-based metal according to Claim 1 or 2, wherein said triazole-based compound is 1, 2, 4-triazole or its derivative.

[Claim 4] The slurry for polishing copper-based metal according to 15 Claim 1, 2 or 3, wherein a content of said triazole-based compound is not less than 0.05 % by weight but not greater than 0.5 % by weight.

[Claim 5] The slurry for polishing copper-based metal according to one of Claims 1-4, wherein a pH value of said slurry is in a range of 5 to 7.

[Claim 6] The slurry for polishing copper-based metal according to 20 one of Claims 1-5, wherein said silica polishing material is colloidal silica.

[Detailed Explanation of the Invention]

[0001]

[Technical Field to which the Invention Pertains]

The present invention relates to a slurry for polishing copper-based 25 metal that is suitable for a chemical mechanical polishing conducted in a step of forming a copper-based metal interconnection of a semiconductor device.

[0002]

[Prior Art]

In the formation of a semiconductor integrated circuit such as an ULSI for which progress to attain further miniaturization and more densely spaced arrangement has been gathering more speed, copper is a particularly useful material of the electrical connection for forming the interconnection of good performance and high reliability, because of its low electrical resistance and high resistance against the electromigration and the stress migration.

[0003]

Since it is difficult to work copper into shape by means of dry etching, a copper interconnection is currently formed by so-called damascene method, for instance, in the following way.

[0004]

Firstly, a sunken section such as a trench or a connection hole is formed in an insulating film formed on a silicon substrate. Next, after a barrier metal film is formed on the surface inclusive of the inside of this sunken section, a copper film is grown by the plating method so as to fill up this sunken section. Polishing is then carried out by the chemical mechanical polishing (referred to as "CMP" hereinafter) method until the surface of the insulating film other than the sunken section is completely exposed, so that the surface may be planarized. Thereby, the formation of an electrical connection section such as a buried copper interconnection, a via plug or a contact plug, which is made of copper filling the sunken section with a barrier metal film lying therebetween, is accomplished.

[0005]

For the CMP slurry used in the formation of a copper interconnection of

this sort, a slurry which contains an oxidizing agent and a polishing material as the main components and further comprises an organic acid such as an amino acid or a carboxylic acid, is generally used.

[0006]

5           For example, in Japanese Patent Application Laid-open No. 233485/1995, there is disclosed a polishing agent for a copper-based metal which contains an oxidizing agent (hydrogen peroxide), polishing grains, water and at least one type of an organic acid selected from the group consisting of aminoacetic acid (glycine) and amidosulfuric acid.   Further, it is described  
10          therein that, with such a polishing agent being used, through the oxidation effect of the afore-mentioned oxidizing agent, an oxide layer is formed, on the surface of copper or copper alloy, to serve as an etching barrier, while this copper or copper alloy is immersed in the agent, and in polishing copper or copper alloy, the removal of the afore-mentioned oxide layer is made  
15          mechanically, and the afore-mentioned organic acid facilitates to etch the exposed copper or copper alloy.

[0007]

          Further, in Japanese Patent Application Laid-open No. 83780/1996, there are disclosed a polishing agent which contains an oxidizing agent (hydrogen peroxide), water, benzotriazole or its derivative, a polishing agent containing polishing grains and aminoacetic acid (glycine) and/or amidosulfuric acid; and a polishing method wherein a CMP is carried out using this polishing agent to form a film of copper or copper alloy within a sunken section of a substrate.   Further, it is described therein that, by performing the CMP with  
20          this polishing agent, a protective film is formed on the film that is to be polished  
25          so as to prevent the isotropic chemical etching from occurring, and then the

removal of this protective film is made, by mechanical polishing, on the surface of the raised section of the film for polishing, and, thereby, a conductive film of high reliability with little dishing or damage can be formed.

[0008]

5        Further, in Japanese Patent Application Laid-open No. 238709/1999, there is disclosed a CMP slurry for copper polishing, which contains citrate, an oxidizing agent (hydrogen peroxide), a polishing material and 1, 2, 4-triazole or benzotriazole.    Further, it is described therein that the use of the CMP slurry can improve the removing rate of copper and the addition of the afore-  
10        mentioned triazole or benzotriazole can raise the planarity of the copper layer.

[0009]

[Problems to be solved by the Invention]

      In recent years, as the semiconductor integrated circuit has been increasingly miniaturized and its arrangement, more densely spaced, the  
15        increase in interconnection resistance and further complication of the logic circuits which result from the miniaturization of the interconnection have become problems to be coped with, and the employment of the multi-layered interconnection which can reduce the interconnection length has become more and more spreading.    Accompanying the increase in the number of layers  
20        through the employment of the multi-layered interconnection structure, however, the unevenness of the substrate surface grows and the difference in level widens.    The enlargement of the difference in level, owing to the employment of the multi-layered structure may cause various problems including the short-circuited interconnection and the leakage of current, both of which may be  
25        brought about by metal residues left in the sunken section of the upper layer(s) after the CMP, and the focus shift in the step of lithography.    Therefore, it is

essential for the slurry not to create substantial dishing (in other words, to provide a high planarity). Further, in the multi-layered interconnection, the top layer section of the interconnection is used for the interconnection for power supply, the interconnection for signal or the interconnection for clock, and for 5 the sake of lowering these interconnection resistances to reduce the voltage change and improve various characteristics, it is required to make the interconnection trench deep and form thick interconnections. In such a case as a thick copper film is formed and, then, a copper interconnection is formed, the polishing amount of copper which is to be removed in the step of one CMP 10 increases and, thus, the time required for the step of polishing becomes considerably long, giving rise to a problem of lowering the throughput. As a result, copper polishing at a higher polishing rate is strongly demanded.

#### [0010]

In general, in order to polish copper at a high polishing rate, the 15 amounts of components for copper etching such as the oxidizing agent and the acid, which are contained in the polishing slurry, are made higher to raise their chemical effects. However, if the chemical effects of the polishing slurry are too strong, even the copper formed as the buried section may be etched to create a hollow (dishing), and the reliability for the electrical connection section 20 such as the interconnection and the via plug may fall.

#### [0011]

Further, with the intention of suppressing dishing in the copper interconnection or the like, if the content of the dishing inhibitor such as benzotriazole or 1, 2, 4-triazole is made too high, the polishing rate (the 25 removing rate) of copper may drop a great deal. Further, there become liable to arise problems that polishing may generate strong vibrations and that, in a

state where the barrier metal film is exposed, the interconnection edge damage may grow with the exposed section of the barrier metal film being the starting point.

[0012]

5 It is, therefore, difficult to polish copper at a high polishing rate, and, at the same time, prevent the dishing from occurring satisfactorily.

[0013]

10 Accordingly, an object of the present invention is to provide a slurry for CMP that is capable of polishing a copper-based metal at a high polishing rate, and of preventing dishing well from occurring.

[0014]

[Means for solving the Problems]

15 In light of the above problems, the present inventors conducted investigations into the composition of the polishing slurry, paying special attention to the organic acid and the triazole-based compound, and found out that the polishing rate markedly increases when, with an amino acid being employed as the organic acid, the content ratio of the amino acid to the triazole-based compound is within a specific range. An effect of this sort cannot be seen, if a carboxylic acid, which is widely employed as the organic 20 acid, is used instead. In addition to this, the present inventors found out that, the etching rate with an amino acid being used as the organic acid becomes lower than that with a carboxylic acid being used, and these findings led to the present invention.

[0015]

25 Accordingly, the present invention relates to a slurry for polishing copper-based metal containing a silica polishing material, an oxidizing agent,

an amino acid, a triazole-based compound and water, wherein a content ratio of said amino acid to said triazole-based compound (amino acid / triazole-based compound (weight ratio)) is 5 to 8.

[0016]

5 [Modes for carrying out the Invention]

The preferred embodiments of the present invention are described below.

[0017]

10 The slurry for polishing copper-based metal according to the present invention contains a silica polishing material (polishing grains), an oxidizing agent, an amino acid and a triazole-based compound.

[0018]

15 As a polishing material in the present invention, it is preferable to use a silica polishing material such as colloidal silica or fumed silica, from the viewpoints that it produces few scratches on the polished face and it has excellent dispersion stability. Especially, colloidal silica is preferable because this, in particular, hardly produces scratches, owing to its spherical grain shape and uniform grain size, and besides this is available with a high purity and numerous types of grade for the particle size are also provided.

20 [0019]

25 In respects of the polishing rate, the dispersion stability, the surface roughness of the polished face and the like, the average particle size of the silica polishing material, measured by the light scattering diffraction method, is preferably not less than 5 nm, more preferably not less than 10 nm and still more preferably not less than 20 nm, but preferably not greater than 100 nm, more preferably not greater than 50 nm and still more preferably not greater

than 30 nm.

[0020]

A content of the silica polishing material to the total amount of the polishing slurry is appropriately set within a range of 0.1 to 50 wt %, taking the 5 polishing efficiency, the polishing accuracy and the like into consideration. In particular, from the viewpoints of the polishing rate, the dispersion stability, the surface roughness of the polished face and the like, it is set preferably not less than 0.5 wt % and more preferably not less than 1 wt %, but preferably not greater than 10 wt % and more preferably not greater than 5 wt %.

10 [0021]

An oxidizing agent in the present invention may be appropriately selected from well known water-soluble oxidizing agents, taking the polishing accuracy and the polishing efficiency into consideration. For example, those which may cause little metal ion contamination include peroxides such as  $H_2O_2$ , 15  $Na_2O_2$ ,  $Ba_2O_2$  and  $(C_6H_5C)_2O_2$ ; hypochlorous acid ( $HClO$ ); perchloric acid; nitric acid; ozone water; peracetic acid; nitrobenzene and organic peroxides. Among these, hydrogen peroxide ( $H_2O_2$ ) is preferable because it does not contain a metal component or does not generate a harmful byproduct.

[0022]

20 A content of the oxidizing agent to the total amount of the polishing slurry in the present invention is appropriately set within a range of 0.01 to 10 wt %, taking the polishing efficiency, the polishing accuracy and the like into consideration. The content thereof is preferably not less than 0.1 wt% and more preferably not less than 0.2 wt% to achieve a better polishing rate; but 25 preferably not greater than 5 wt% and more preferably not greater than 2 wt% to suppress the dishing and regulate the polishing rate. When the content of

the oxidizing agent is too low, the chemical effects of the polishing slurry become small so that the polishing rate obtained may become insufficient or the damage may become liable to happen on the polished face. On the other hand, when the content of the oxidizing agent is too high, the dishing may

5 become liable to happen or copper oxide (CuO) may be excessively formed on the surface of the copper-based metal film, which may bring about, through the inhibition of adsorption of the triazole-based compound, undesirable results such as a lowering of the polishing rate and the rough polished surface.

[0023]

10 In the case that hydrogen peroxide is utilized as an oxidizing agent, an excellent polishing slurry can be obtained by adding, for example, an aqueous solution of hydrogen peroxide with a concentration of 30 wt % to a concentration of 1 to 5 wt % in the slurry (H<sub>2</sub>O<sub>2</sub> concentration : 0.3 to 1.5 wt %). Nevertheless, when such an oxidizing agent relatively susceptible to

15 deterioration with age as hydrogen peroxide is utilized, it may be possible to prepare separately a solution containing, together with a stabilizer and the like, an oxidizing agent at a given concentration, and a composition which is to provide a prescribed polishing slurry on addition of the solution containing the oxidizing agent, and then mix them just before use.

20 [0024]

An amino acid that the polishing slurry of the present invention contains is an essential component. If this amino acid and a triazole-based compound are contained therein at a specific ratio as described below, the dishing can be well prevented from occurring, and besides a copper-based

25 metal film can be polished at a high polishing rate.

[0025]

An amino acid in the present invention may be added as a single substance or added as a salt or a hydrate. Examples thereof include arginine, arginine hydrochloride, arginine picrate, arginine flavianate, lysine, lysine hydrochloride, lysine dihydrochloride, lysine picrate, histidine, histidine hydrochloride, histidine dihydrochloride, glutamic acid, sodium glutaminic acid monohydrate, glutamine, glutathione, glycylglycine, alanine,  $\beta$ -alanine,  $\gamma$ -aminobutyric acid,  $\epsilon$ -aminocaproic acid, aspartic acid, aspartic acid monohydrate, potassium aspartate, calcium aspartate trihydrate, tryptophan, threonine, glycine, cysteine, cysteine hydrochloride monohydrate, oxyproline, isoleucine, leucine, methionine, ornithine hydrochloride, phenylalanine, phenylglycine, proline, serine, tyrosine and valine. It is also possible to add two or more different types of amino acids selected therefrom. Among these amino acids, glycine is preferable in respects of the polishing rate and the suppressing effect on the dishing. Further, as glycine is highly soluble, glycine is preferable also in respect of the production of the polishing slurry, and, in addition to that, glycine is available at a low price so that its use enables the low cost production of the polishing slurry.

[0026]

With regard to a content of the amino acid in the polishing slurry of the present invention, it is essential to set this content in such a way that a content ratio of the amino acid to the triazole-based compound that is to be described below (amino acid / triazole-based compound (weight ratio)) is in a range of 5 to 8. This content ratio is set in a range of preferably 5 to 7.5, more preferably 5 to 7 and still more preferably 6 to 7. When this content ratio is too small, the polishing ratio is lowered. However, when this content ratio is too large, the polishing ratio is again lowered. Further, in this case (in the

case the content ratio is too large), namely, when the amino acid is excess and/or when the triazole-based compound is scarce, the dishing becomes liable to happen.

[0027]

5        The polishing slurry of the present invention may contain another organic acid other than the afore-mentioned amino acid as far as the prescribed characteristics are not adversely affected. An addition of an organic acid may facilitate an oxidizing agent to dissolve copper and to carry out polishing stably. Examples of such an organic acid include various 10 carboxylic acids, for instance, oxalic acid, malonic acid, tartaric acid, malic acid, glutaric acid, citric acid, maleic acid, formic acid, acetic acid, propionic acid, butyric acid, valeric acid, acrylic acid, lactic acid, succinic acid, nicotinic acid and their salts.

[0028]

15       The polishing slurry of the present invention further contains a triazole-based compound. By this triazole-based compound, a protective film is formed on the surface of the copper-based metal film, which blocks the etching effect (chemical effect) thereon except at the time of being polished and, thus, prevents the dishing from occurring. Further, as described above, by being 20 contained at a specific ratio to the amino acid, the triazole-based compound can raise the polishing rate.

[0029]

25       A content of the triazole-based compound in the polishing slurry of the present invention is preferably not less than 0.05 wt%, more preferably not less than 0.06 wt% and still more preferably not less than 0.07 wt%, but preferably not greater than 0.5 wt%, more preferably not greater than 0.4 wt% and still

more preferably not greater than 0.3 wt%. When the content of the triazole-based compound is too low, the etching rate increases and the extent of dishing becomes larger. On the other hand, when the content of the triazole-based compound is too high, the polishing rate drops, although the suppressing effects on the dishing can remain.

5 [0030]

A triazole-based compound in the present invention implies triazole or its derivative. Examples of a triazole-based compound include 1, 2, 4-triazole, 1, 2, 3-triazole and their derivatives (substitution products having at least a substituent attached to a carbon atom in the heterocyclic five-membered ring). As examples of a substituent attached to a carbon atom in the heterocyclic five-membered ring of triazole, there can be given hydroxy group; alkoxy group such as metoxy group and ethoxy group; amino group; nitro group; alkyl group such as methyl group, ethyl group and butyl group; and halogen substituent group such as fluorine, chlorine, bromine and iodine, and, herein, it is possible that only one of two carbons in the heterocyclic five-membered ring have a substituent or both carbons have each, either the same type or different substituent. Among these compounds, 1, 2, 4-triazole is preferable because of its water solubility and its acquisition cost such as price.

20 [0031]

A pH value of the polishing slurry of the present invention is set to be preferably in a range of pH 3 to 8, viewed from the points of the polishing rate, the prevention of dishing, the corrosion and surface roughness on the polished face, the viscosity of the slurry and the dispersion stability. Especially, in respects of the polishing rate and the prevention of dishing, pH 5 to 7 is more preferable, and further, with the dispersion stability of the polishing material

considered, pH 6 to 7 is more preferable, and pH 6.5 to 7 is particularly preferable. When the pH is too low, the etching power may become strong and the dishing may become liable to happen. On the other hand, when the pH is too high, the effect of the oxidizing agent becomes weaker and, moreover, 5 the handling easiness of the slurry becomes lowered, regarding safety. In addition, when the pH is excessively high, the etching power becomes so strong that the extent of the dishing tends to increase, again.

[0032]

10 The pH of the polishing slurry may be adjusted by any well-known method, and examples of an alkali which may be employed for that include alkali metal hydroxides such as sodium hydroxide and potassium hydroxide; alkali metal carbonates such as sodium carbonate and potassium carbonate; ammonia; and amines. Among them, ammonia and amines which contain no metal component are preferable.

15 [0033]

The polishing slurry of the present invention may contain a variety of additives such as a dispersing agent, a buffer agent and a viscosity modifier, which are in wide use as common additives to the polishing slurry, provided that it does not affect adversely the properties of the slurry.

20 [0034]

For a method of preparing the polishing slurry of the present invention, an ordinary method of preparing an aqueous polishing slurry composition with free grains can be applied. Specifically, an appropriate amount of a polishing material is added to an aqueous solvent and then, if necessary, with an 25 appropriate amount of a dispersing agent being added, a treatment of dispersion is carried out. In the step of the dispersion, for example, an

ultrasonic disperser, a bead mill disperser, a kneader disperser, a ball mill disperser or the like may be used, according to the circumstances.

[0035]

The CMPs using a polishing slurry of the present invention, for 5 example, can be conducted, as follows. Firstly, there is provided a substrate, wherein an insulating film is formed and a sunken section in prescribed pattern shape is formed in the insulating film and, thereon, a copper-based metal film is grown. This substrate is placed on a wafer carrier such as a spindle. With a prescribed pressure applied, the surface of this copper-based metal film in 10 this substrate is made to contact with a polishing pad which is adhered onto a surface plate such as a rotary plate, and while supplying a polishing slurry between the substrate and the polishing pad, the wafer and the polishing pad are moved relative to each other (for instance, both of them are rotated) and thereby the wafer is polished. The polishing slurry may be supplied onto the 15 polishing pad from a supply tube set separately or it may be supplied onto the surface of the polishing pad from the side of the surface plate. If necessary, a pad conditioner may be brought into contact with the surface of the polishing pad to condition the surface of the polishing pad.

[0036]

20 The polishing slurry of the present invention described above is the most effective when a sunken section such as a trench or a connection hole is formed in an insulating film laid on a substrate, a copper-based metal film is formed over the entire surface thereof so as to fill up this sunken section with a barrier metal film lying therebetween, and by CMP polishing the copper-based 25 metal film, an electrical connection section such as a buried interconnection, a via plug, a contact and the like is formed. As an insulating film, there can be

given a silicon oxide film, a BPSG film, a SOG film, a SiOF film, a HSQ film, a SiOC film, a MSQ film, a polyimide film, a Parylene film (polyparaxylylene film), a Teflon film and an amorphous carbon film. As a barrier metal film well suited to the copper-based metal film, that is, the copper film or the copper alloy film whose main component is copper, there can be given a tantalum-based metal film made of tantalum (Ta), a tantalum nitride, tantalum silicon nitride or the like.

5 [0037]

[Examples]

10 The present invention is further illustrated by the following examples in detail below.

[0038]

[CMP Conditions]

15 The CMP was carried out using a polisher SH-24 made by SpeedFam Co., Ltd. The polisher was used, onto a surface plate of which a polishing pad (IC 1400, made by Rodel Nitta Company) with a diameter of 61 cm was attached. Polishing conditions were as follows; a contact pressure of the polishing pad : 27.6 kPa, a polishing area of the polishing pad : 1820 cm<sup>2</sup>, a rotating speed of the surface plate : 55 rpm; a carrier rotating speed : 55 rpm; 20 and a feeding rate of the slurry polishing agent: 100 ml/min.

[0039]

For a substrate for polishing, a substrate in which a copper film was grown on a Si substrate by the sputtering method was used.

[0040]

25 [Measurement of Polishing Rate]

The polishing rate was calculated from the surface resistivities before

and after the polishing as follows. Four needle electrodes were aligned on the wafer with a given interval, and with a given current being applied between two outer probes, a potential difference between two inner probes was measured to determine a resistance ( $R'$ ), and further a surface resistivity ( $\rho s'$ ) 5 was obtained by multiplying that value by a correction factor RCF (Resistivity Correction Factor). A surface resistivity ( $\rho s$ ) for another wafer film with a known thickness ( $T$ ) (nm) was also obtained. Since the surface resistivity is inversely proportional to the thickness, if a thickness for the wafer with the surface resistivity of  $\rho s'$  is taken as  $d$ , an equation

10 
$$d \text{ (nm)} = (\rho s \times T) / \rho s'$$

is given. Using this equation, the thickness  $d$  can be determined, and the polishing rate was then estimated by dividing the difference between film thicknesses before and after the polishing by the polishing time. For the measurements of the surface resistivity, a surface resistance detector (Four 15 Probe Resistance Detector, Loresta-GP, made by Mitsubishi Chemical Corporation) was used.

[0041]

#### [Measurement of Etching Rate]

A Si substrate on which a Cu film was grown was cleaved into a size of 20  $1.2 \times 1.2 \text{ cm}^2$  and this was subjected to an immersion in 50 ml of a polishing slurry at  $25^\circ\text{C}$  for 30 minutes. The surface resistivities ( $\rho s'$ ) of the Cu film before and after the immersion were measured by the surface resistance detector (Four Probe Resistance Detector, Loresta-GP, made by Mitsubishi Chemical Corporation). Using the afore-mentioned relationship 25 equation " $d \text{ (nm)} = (\rho s \times T) / \rho s'$ ", the film thickness after the immersion was obtained and then the etching rate was calculated by dividing the

difference between film thicknesses before and after the immersion by the immersion time.

[0042]

[Estimation of Dispersion Stability]

5           Using a self-recording spectrophotometer (U-4000 Type, made by Hitachi, Ltd.), the transmittance of the slurry was measured 3000 hours after the preparation of the slurry.

[0043]

[Preparation of Polishing Slurry and Results of Estimation]

10           A number of slurries each of which contained 5 wt % of colloidal silica (TSOL Series, made by Tama Chemicals Co., Ltd.; primary particle size : approximately 30 nm), 2 wt % of an aqueous solution of 30 wt % hydrogen peroxide (the amount of  $H_2O_2$  : 0.6 wt %), 1, 2, 4-triazole, glycine and water were prepared. The contents of 1, 2, 4-triazole and glycine in each slurry are 15 listed in Table 1. Further, the pH value of each slurry was adjusted to be within a range of 6.5 to 7 with an aqueous solution of ammonia.

[0044]

20           The results of measurements of the polishing rate and the etching rate for each slurry are shown in Table 1 and Fig. 1. These results show that a high polishing rate can be obtained when the content ratio of glycine to 1, 2, 4-triazole (glycine content ratio) is in a specific range. Further, it is clearly seen that the etching ratio increases with higher glycine content ratios. These results indicate that, in order to suppress etching satisfactorily, in other words, in order to prevent dishing from occurring and, at the same time, obtain a high polishing rate, it is preferable for the glycine content ratio to be in a range of 5 to 8, and especially in a range of 6 to 7.

[0045]

[Table 1]

Table 1

| Slurry No. | 1,2,4-triazole content (wt%) | Glycine content ratio | Polishing Rate (nm/min) | Etching Rate (nm/min) |
|------------|------------------------------|-----------------------|-------------------------|-----------------------|
| 1          | 0.075                        | 3                     | 110                     | 0.9                   |
| 2          | 0.075                        | 5                     | 249                     | 0.8                   |
| 3          | 0.075                        | 7                     | 395                     | 0.8                   |
| 4          | 0.075                        | 10                    | 230                     | 2.2                   |
| 5          | 0.1                          | 3                     | 120                     | 0.5                   |
| 6          | 0.1                          | 5                     | 310                     | 0.6                   |
| 7          | 0.1                          | 7                     | 455                     | 0.6                   |
| 8          | 0.1                          | 10                    | 280                     | 1.7                   |
| 9          | 0.3                          | 3                     | 110                     | 0.5                   |
| 10         | 0.3                          | 6                     | 360                     | 0.4                   |
| 11         | 0.3                          | 7                     | 370                     | 0.8                   |
| 12         | 0.3                          | 10                    | 320                     | 1.8                   |

$H_2O_2$  content (wt%) : 0.6 wt %

5

[0046]

The results of measurements of the polishing rate at a glycine content ratio of 7 with various hydrogen peroxide contents are shown in Table 2.

These results demonstrate that even if the content of hydrogen peroxide increases more than necessary, a high polishing rate cannot be obtained and,

10 on the contrary, a decrease in polishing rate may be brought about.

[0047]

[Table 2]

Table 2

| Slurry No. | $H_2O_2$ content (wt %) | 1,2,4-triazole content (wt%) | Glycine content ratio | Polishing rate (nm/min) |
|------------|-------------------------|------------------------------|-----------------------|-------------------------|
| 7          | 0.6                     | 0.1                          | 7                     | 455                     |
| 13         | 0.9                     | 0.1                          | 7                     | 690                     |
| 14         | 1.5                     | 0.1                          | 7                     | 450                     |
| 15         | 3.0                     | 0.1                          | 7                     | 380                     |

5 [0048]

The results of measurements of the polishing rate obtained using slurries with various pHs whose glycine content ratio is 6 are shown in Fig. 2. These results indicate that high polishing rates may be obtained at pH 5 to 7.

10 [0049]

The results of measurements of the transmittance of the polishing slurry obtained using slurries with various pHs whose glycine content ratio is 6 are shown in Fig. 3. These results indicate that at a pH not less than 6 and especially at a pH not less than 6.5, the slurry shows an excellent dispersion stability.

15 [0050]

As Case for Comparison, the results of measurements of the polishing rate and the etching rate for polishing slurries each of which contains benzotriazole in place of 1, 2, 4-triazole contained in each slurry shown in Table 1 are shown in Table 3. These results demonstrate that, with a polishing slurry containing benzotriazole, a high polishing rate cannot be obtained. It is thought that because benzotriazole is liable to be adsorbed strongly to form a hard firm coating, a high polishing rate cannot be obtained.

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[0051]

[Table 3]

Table 3

| Slurry No. | Benzotriazole content (wt%) | Glycine content ratio | Polishing rate (nm/min) | Etching rate (nm/min) |
|------------|-----------------------------|-----------------------|-------------------------|-----------------------|
| 16         | 0.005                       | 3                     | 42                      | 0.9                   |
| 17         | 0.005                       | 5                     | 119                     | 0.8                   |
| 18         | 0.005                       | 7                     | 122                     | 0.9                   |
| 19         | 0.005                       | 10                    | 98                      | 2.5                   |
| 20         | 0.01                        | 3                     | 82                      | 0.5                   |
| 21         | 0.01                        | 5                     | 178                     | 0.5                   |
| 22         | 0.01                        | 7                     | 152                     | 0.6                   |
| 23         | 0.01                        | 10                    | 130                     | 1.2                   |
| 24         | 0.02                        | 3                     | 57                      | 0.7                   |
| 25         | 0.02                        | 5                     | 140                     | 0.8                   |
| 26         | 0.02                        | 7                     | 152                     | 0.7                   |
| 27         | 0.02                        | 10                    | 85                      | 1.8                   |

$H_2O_2$  content (wt %) : 0.6 wt %

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[0052]

As Case for Comparison, the results of measurements of the polishing rate and the etching rate for polishing slurries each of which contains tartaric acid or citric acid in place of glycine contained in each slurry shown in Table 1 are shown in Table 4. These results demonstrate that, with a polishing slurry containing a carboxylic acid instead of an amino acid, a high polishing rate cannot be obtained, while suppressing the etching rate.

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[0053]

[Table 4]

Table 4

| Slurry No. | Carboxylic acid | Carboxylic acid content ratio | Polishing rate (nm/min) | Etching rate (nm/min) |
|------------|-----------------|-------------------------------|-------------------------|-----------------------|
| 28         | Tartaric acid   | 5                             | 110                     | 1.0                   |
| 29         | Tartaric acid   | 7                             | 145                     | 1.8                   |
| 30         | Tartaric acid   | 10                            | 180                     | 2.8                   |
| 31         | Citric acid     | 4                             | 240                     | 10.0                  |
| 32         | Citric acid     | 7                             | 250                     | 17.0                  |
| 33         | Citric acid     | 10                            | 320                     | 23.0                  |

$H_2O_2$  content (wt %) : 0.6 wt % ; 1, 2, 4-triazole content : 0.1 wt %

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[0054]

[Effects of the Invention]

As set forth above, the present invention can provide a slurry for CMP that is capable of polishing the copper-based metal film at a high polishing rate, and of preventing the dishing from occurring satisfactorily.

10 [Brief Explanation of the Drawing]

[Fig. 1]

Fig. 1 is a graph showing the relationships between the content ratio of glycine to 1, 2, 4-triazole in the polishing slurry and the polishing rate, and the etching rate.

15 [Fig. 2]

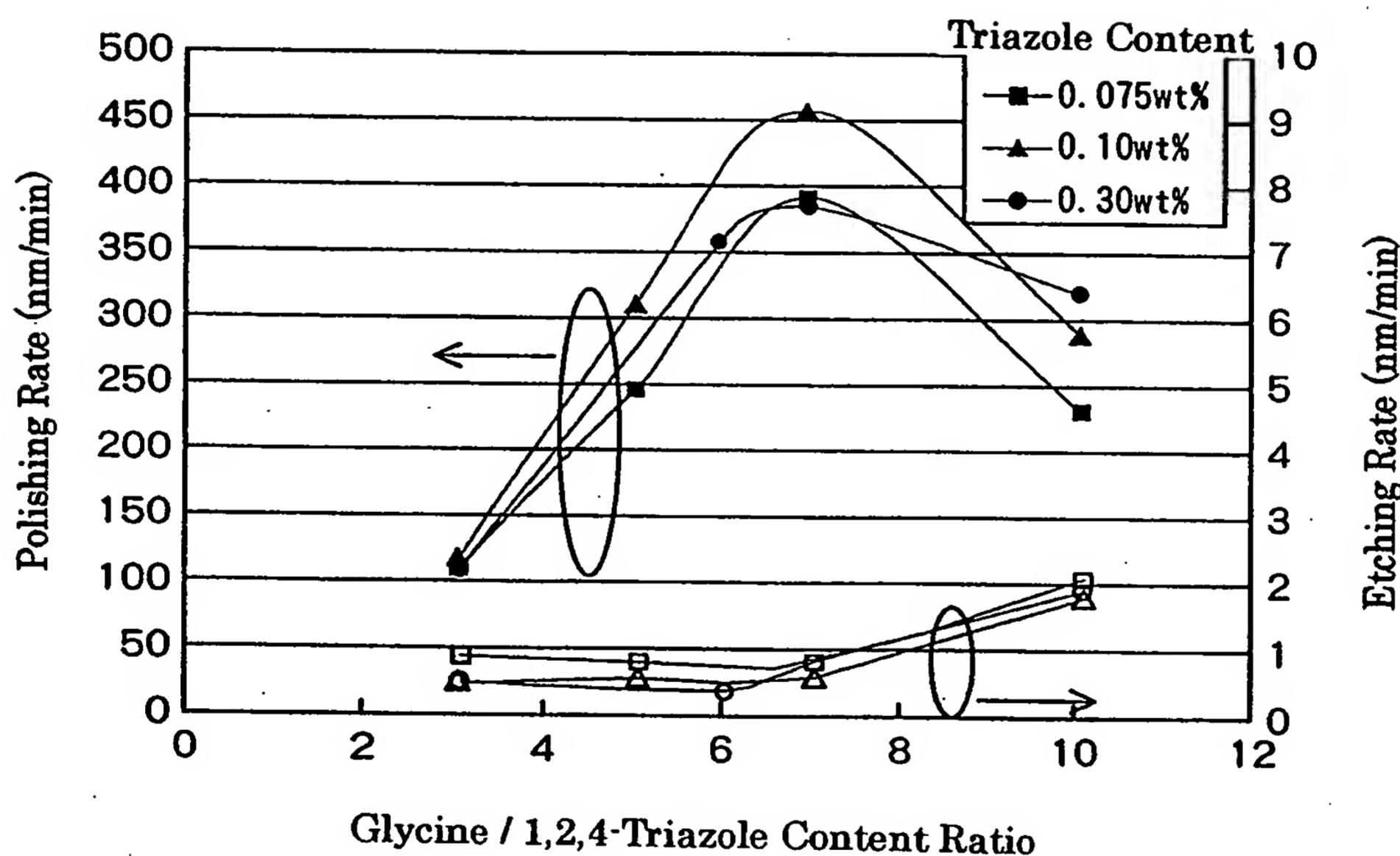
Fig. 2 is a graph showing the relationship between the pH of the polishing slurry and the polishing rate.

[Fig. 3]

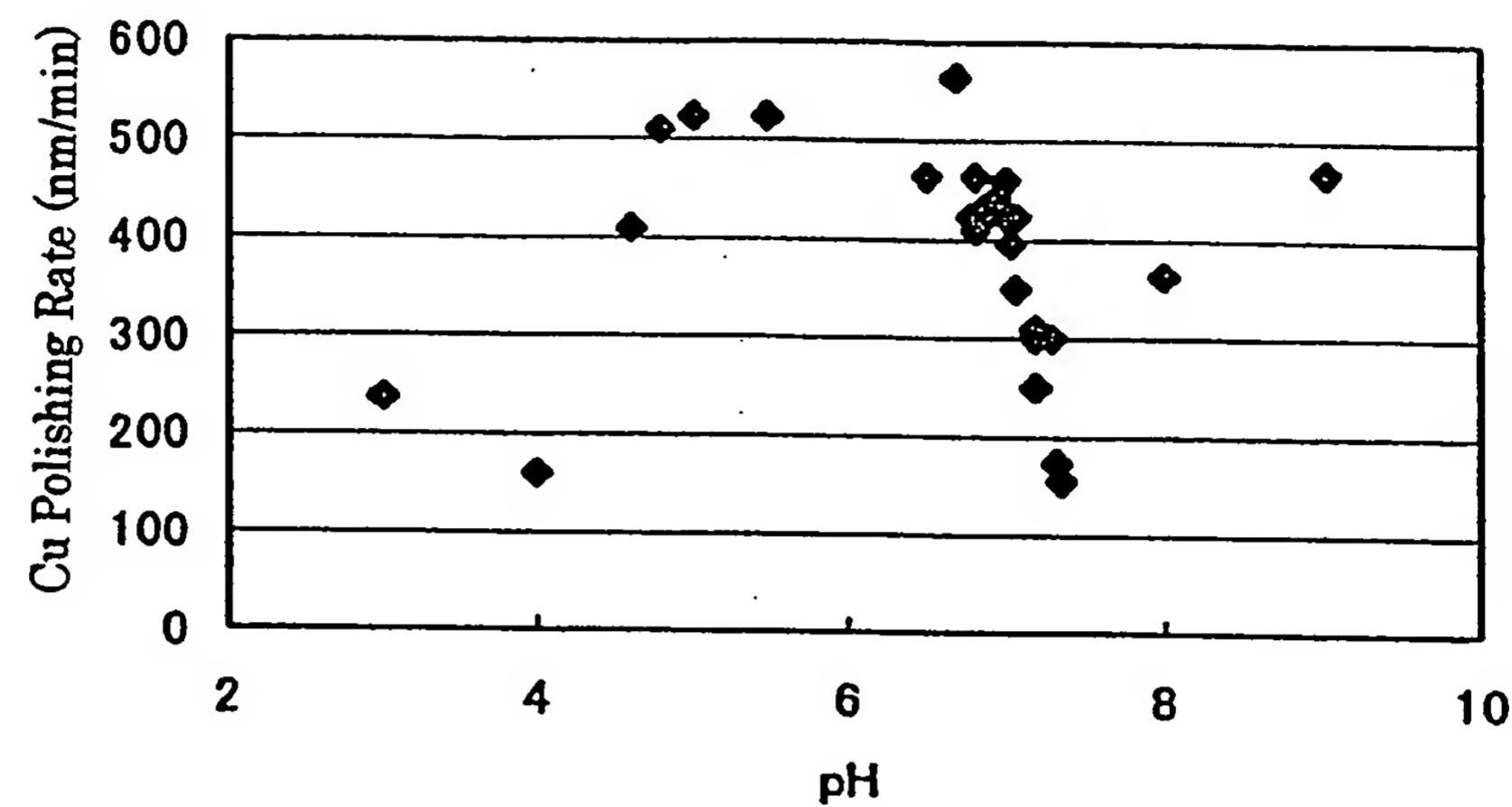
20 Fig. 3 is a graph showing the relationship between the pH of the polishing slurry and the transmittance thereof.

[Document Name] Drawings

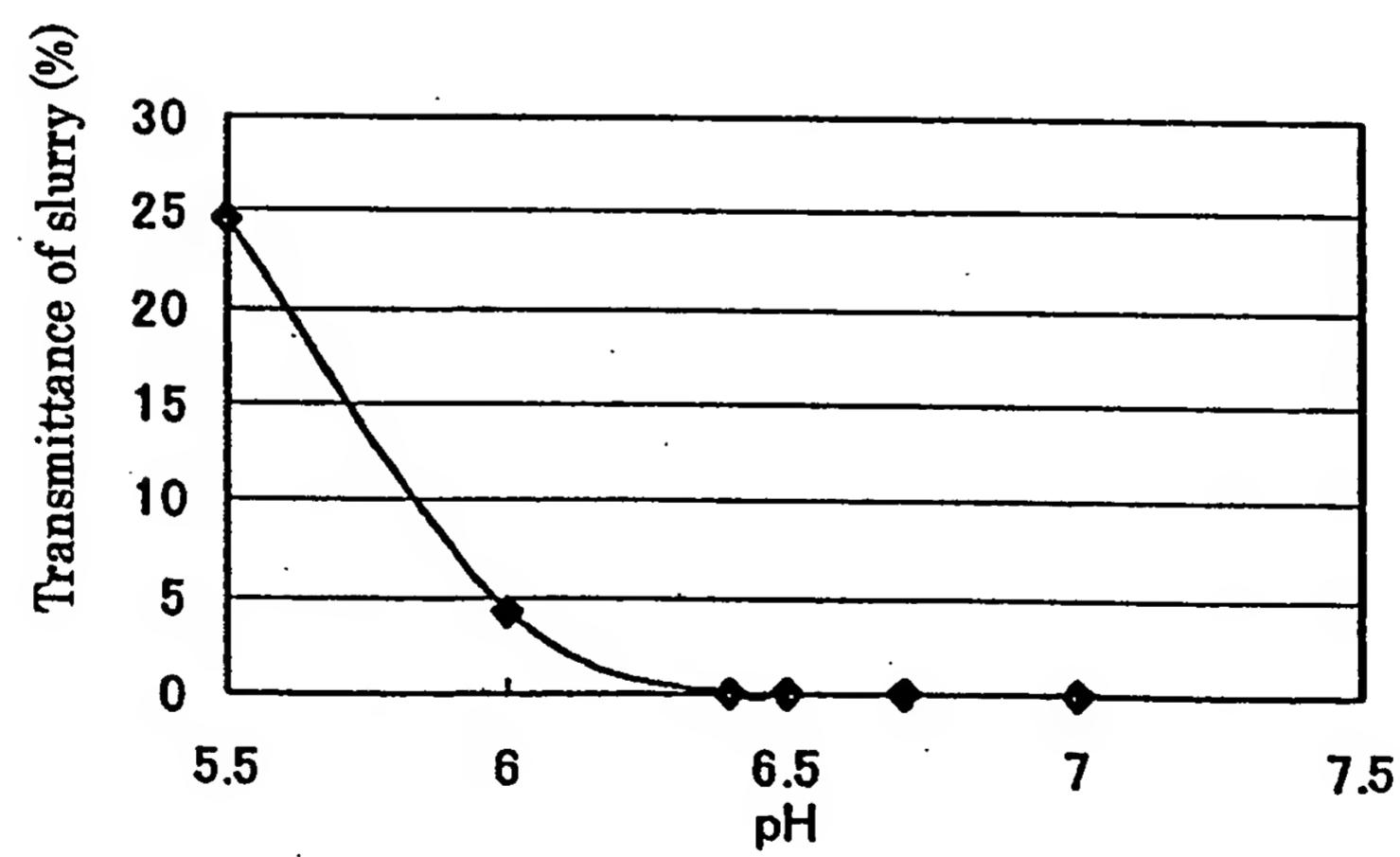
FIG. 1



**FIG. 2**



**FIG. 3**



[Document Name] Abstract

[Abstract]

[Problems] An object of the present invention is to provide a slurry for CMP that is capable of polishing a copper-based metal at a high polishing rate, and  
5 of preventing dishing well from occurring.

[Means for Solving the Problems] The present invention relates to a slurry for polishing containing a silica polishing material, an oxidizing agent, an amino acid, a triazole-based compound and water, wherein a content ratio of the amino acid to the triazole-based compound (amino acid / triazole-based  
10 compound (weight ratio)) is 5 to 8.

[Chosen Drawing] none